
**Petroleum and natural gas industries —
External coatings for buried or
submerged pipelines used in pipeline
transportation systems —**

Part 1:

**Polyolefin coatings (3-layer PE and
3-layer PP)**

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*Industries du pétrole et du gaz naturel — Revêtements externes des
conduites enterrées ou immergées utilisées dans les systèmes de
transport par conduites —*

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*Partie 1: Revêtements à base de polyoléfines (PE tricouche et
PP tricouche)*



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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 21809-1 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 2, *Pipeline transportation systems*.

ISO 21809 consists of the following parts, under the general title *Petroleum and natural gas industries — External coatings for buried or submerged pipelines used in pipeline transportation systems*:

- *Part 1: Polyolefin coatings (3-layer PE and 3-Layer PP)*
- *Part 2: Fusion-bonded epoxy coatings*
- *Part 3: Field joint coatings*
- *Part 4: Polyethylene coatings (2-layer PE)*
- *Part 5: External concrete coatings*

A Part 6 dealing with multilayer fusion-bonded epoxy coatings (FBE), a Part 7 dealing with liquid coatings, a Part 8 dealing with thermal insulation coatings, and a Part 9 dealing with epoxy polyamide powder coatings (2-layer) are under preparation.

Introduction

It is necessary that users of this part of ISO 21809 be aware that further or differing requirements can be required for individual applications. This part of ISO 21809 is not intended to inhibit a vendor from offering, or the purchaser from accepting, alternative equipment or engineering solutions for the individual application. This can be particularly applicable where there is innovative or developing technology. Where an alternative is offered, it is the responsibility of the vendor to identify any variations from this part of ISO 21809 and provide details.

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Petroleum and natural gas industries — External coatings for buried or submerged pipelines used in pipeline transportation systems —

Part 1: Polyolefin coatings (3-layer PE and 3-layer PP)

1 Scope

This part of ISO 21809 specifies requirements of plant-applied external three-layer polyethylene- and polypropylene-based coatings for corrosion protection of welded and seamless steel pipes for pipeline transportation systems in the petroleum and natural gas industries in accordance with ISO 13623.

NOTE Pipes coated in accordance with this part of ISO 21809 are considered suitable for further protection by means of cathodic protection.

2 Conformance

2.1 Rounding

Unless otherwise stated in this part of ISO 21809, to determine conformance with the specified requirements, observed or calculated values shall be rounded to the nearest unit in the last right-hand place of figures used in expressing the limiting value, in accordance with ISO 80000-1.

NOTE For the purpose of this provision, the rounding method of ASTM E29 is equivalent to ISO 80000-1.

2.2 Compliance with standard

A quality system and an environmental management system should be applied to assist compliance with the requirements of this part of ISO 21809.

NOTE ISO/TS 29001 gives sector-specific guidance on quality management systems and ISO 14001 gives guidance on the selection and use of an environmental management system.

The applicator shall be responsible for complying with all the applicable requirements of this part of ISO 21809. The purchaser shall be allowed to make any investigations necessary to ensure compliance by the applicator and to reject any material and/or coating that does not comply.

3 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 179-1, *Plastics — Determination of Charpy impact properties — Part 1: Non-instrumented impact test*

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- ISO 179-2, *Plastics — Determination of Charpy impact properties — Part 2: Instrumented impact test*
- ISO 306, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST)*
- ISO 527-2, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics*
- ISO 527-3, *Plastics — Determination of tensile properties — Part 3: Test conditions for films and sheets*
- ISO 868, *Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness)*
- ISO 1133, *Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics*
- ISO 1183 (all parts), *Plastics — Methods for determining the density of non-cellular plastics*
- ISO 1872-2, *Plastics — Polyethylene (PE) moulding and extrusion materials — Part 2: Preparation of test specimens and determination of properties*
- ISO 1873-2, *Plastics — Polypropylene (PP) moulding and extrusion materials — Part 2: Preparation of test specimens and determination of properties*
- ISO 2808, *Paints and varnishes — Determination of film thickness*
- ISO 2811 (all parts), *Paint and varnishes — Determination of density*
- ISO 3251, *Paints, varnishes and plastics — Determination of non-volatile matter content*
- ISO 4892-2:2006, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps*
- ISO 8130-2, *Coating powders — Part 2: Determination of density by gas comparison pycnometer (referee method)*
- ISO 8130-3, *Coating powders — Part 3: Determination of density by liquid displacement pycnometer*
- ISO 8501-1:2007 *Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings*
- ISO 8502-3, *Preparation of steel substrates before application of paints and related products — Test for the assessment of surface cleanliness — Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method)*
- ISO 8502-6, *Preparation of steel substrates before application of paints and related products — Test for the assessment of surface cleanliness — Part 6: Extraction of soluble contaminant for analysis — The Bresle method*
- ISO 8502-9, *Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness — Part 9: Field method for the conductometric determination of water-soluble salts*
- ISO 8503-4, *Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 4: Method for the calibration of ISO surface profile comparators and for the determination of surface profile — Stylus instrument procedure*
- ISO 8503-5, *Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 5: Replica tape method for the determination of the surface profile*
- ISO 10474:1991, *Steel and steel products — Inspection documents*

ISO 11124 (all parts), *Preparation of steel substrates before application of paints and related products — Specifications for metallic blast-cleaning abrasives*

ISO 11126 (all parts), *Preparation of steel substrates before application of paints and related products — Specifications for non-metallic blast-cleaning abrasives*

ISO 11127-6, *Preparation of steel substrates before application of paints and related products — Test methods for non-metallic blast cleaning abrasives — Part 6: Determination of water-soluble contaminants by conductivity measurement*

ISO 11357 (all parts), *Plastics — Differential scanning calorimetry (DSC)*

ISO 13623, *Petroleum and natural gas industries — Pipeline transportation systems*

ISO 15512, *Plastics — Determination of water content*

ISO 80000-1, *Quantities and units — Part 1: General*

AS 3894-6, *Site testing of protective coatings — Determination of residual contaminants*

ASTM D792¹⁾, *Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement*

ASTM D1505, *Standard Test Method for Density of Plastics by the Density-Gradient Technique*

ASTM D1693, *Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics*

ASTM D4138, *Standard Practice for Measurement of Dry Film Thickness of Protective Coating Systems by Destructive, Cross-Sectioning Means*

ASTM D4940, *Standard Test Method for Conductimetric Analysis of Water Soluble Ionic Contamination of Blasting Abrasives*

EN 10204:2004²⁾, *Metallic materials — Types of inspection documents*

SSPC-AB 1, *Mineral and Slag Abrasives*

SSPC-AB 2, *Cleanliness of Recycled Ferrous Metallic Abrasives*

SSPC-AB 3, *Ferrous Metallic Abrasive*

SSPC-SP 1³⁾, *Solvent Cleaning*

4 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

4.1

adhesion

bond between coating and substrate after environmental testing

1) American Society for Testing and Materials, 100 Harbour Drive, West Conshohocken, PA 19428-2959, USA.

2) CEN, European Committee for Standardization, Central Secretariat, Rue de Stassart 36, B-1050, Brussels, Belgium.

3) Society for Protective Coatings, 40 24th Street, 6th Floor, Pittsburg, PA 15222-4656, USA.

4.2 applicator
company that undertakes the coating application in accordance with the provisions of this part of ISO 21809

NOTE If the compounding of the top layer is done prior to or during the application process by the applicator, then the applicator is regarded as the manufacturer (see 4.13).

**4.3 application procedure specification
APS**
document describing procedures, methods, equipment and tools used for coating application

4.4 batch
quantity of material produced in a continuous manufacturing operation using raw materials of the same source and grade

4.5 batch certificate
certificate of analysis issued by the manufacturer

4.6 certificate of compliance
document issued in accordance with ISO 10474 or EN 10204, stating compliance with the purchase order for coated pipes, but without mention of any test results, issued in accordance with the purchasing requirements

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4.7 cutback
length of pipe left uncoated at each end for joining purposes

4.8 design temperature range
temperature range including maximum and minimum temperatures likely to be reached during transport, handling, installation and operation

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NOTE The design temperature range of the coating may be narrower than that specified for the steel pipe material and/or the pipeline system.

4.9 end user
company (companies) that own(s) and/or operate(s)

4.10 holiday
coating discontinuity that exhibits electrical conductivity when exposed to a specific voltage

**4.11 inspection certificate 3.1.B
inspection certificate 3.1**
document in accordance with ISO 10474 or EN 10204 giving the results of the testing of coated pipes, supplied and signed by a representative of the applicator authorized to issue such documents

**4.12 inspection and testing plan
ITP**
document providing an overview of the sequence of inspections and tests, including appropriate resources and procedures

4.13**manufacturer**

company responsible for the manufacture of coating material(s)

4.14**manufacturer's specification**

document that specifies the characteristics, test requirements and application recommendations for the coating materials

4.15**operating temperature**

maximum and/or minimum temperature that can be endured by a pipeline (component) and/or pipeline system during operation, and that shall be within the design temperature range

4.16**peel strength**

force required for peeling the coating from the substrate

4.17**pipe diameter length**

any length along the pipe axis equal to the specified outside diameter of the pipe

4.18**pipeline**

those facilities through which fluids are conveyed, including pipe, pig traps, components and appurtenances, up to and including the isolating valves

NOTE

Adapted from ISO 13623:2009, definition 3.14.

4.19**pipeline system**

pipeline with compressor or pump stations, pressure control stations, flow control stations, metering, tankage, supervisory control and data acquisition system (SCADA), safety systems, corrosion protection systems, and any other equipment, facility or building used in the transportation of fluids

NOTE

Adapted from ISO 13623:2009, definition 3.16.

4.20**procedure qualification trial****PQT**

application of a coating and subsequent inspection/testing of its properties, to confirm that the APS is adequate to produce a coating with the specified properties, carried out prior to the start of production

4.21**purchaser**

company responsible for providing the purchase order requirements

4.22**test report**

document that provides the quantitative test results for tests conducted in accordance with the requirements of this part of ISO 21809

4.23**total coating thickness**

sum of all three layers

5 Symbols and abbreviated terms

5.1 Symbols

C	percentage conversion of FBE coating
d	effective sample thickness, expressed in millimetres
D	outside diameter of the pipe, expressed in millimetres
ΔH	exothermic heat of reaction, expressed in Joules per gram
M	mass, expressed in kilograms or grams
P_m	mass of pipe per metre length, expressed in kilograms per metre
dQ/dt	differential heat flow, expressed in watts per square metre
r	mandrel radius, expressed in millimetres
R_{MF}	melt flow rate, expressed in grams per 10 minutes
T_g	glass transition temperature, expressed in degrees Celsius
ΔT_g	difference in the glass transition temperature between two successive thermal analysis scans, expressed in degrees Celsius
w_m	mass fraction of moisture, expressed as a percentage
ρ_p	density of the epoxy powder, expressed in grams per litre

5.2 Abbreviations

	ISO 21809-1:2011
APS	application procedure specification
DSC	differential scanning calorimetry
ESCR	environmental stress cracking resistance
FBE	fusion-bonded epoxy
HDPE	high-density polyethylene
IR	infrared
ITP	inspection and testing plan
LDPE	low-density polyethylene
MDPE	medium-density polyethylene
MFR	melt flow rate
NPS	nominal pipe size
PDL	pipe diameter length
PE	polyethylene
PP	polypropylene
PPT	preproduction trial
PQT	procedure qualification trial

SAW	submerged arc welding
UV	ultraviolet
3LPE	three-layer polyethylene coating
3LPO	three-layer polyolefin coating
3LPP	three-layer polypropylene coating

6 Information supplied by the purchaser

6.1 General information

The purchase order shall include the following information:

- number of this part of ISO 21809 and year of publication (ISO 21809-1:2011);
- pipe quantity, outside diameter, minimum wall thickness, minimum, maximum and nominal length, grade of steel;
- bare pipe standard or specification designation, e.g. ISO 3183;
- design temperature range in accordance with 7.2;
- coating class and coating thickness class in accordance with 7.2 and 7.3;
- cutback configuration and finish (length, angle, visible epoxy, temporary protection, etc.);
- type of certificate of compliance.

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6.2 Additional information

The purchase order shall specify which of the following provisions apply for the specific item ordered:

- pipe tracking and traceability of pipes to coating materials;
- permissible number of coating repairs, if different from the one defined in Clause 12;
- marking of pipes;
- handling procedures;
- storage procedures;
- documentation and schedule for supply of documentation;
- purchaser approval of APS;
- inspection and testing plan and/or daily log;
- inspection of incoming pipes;
- pipe end protection;
- minimum thickness of epoxy layer and/or total coating thickness required, if exceeding those in Table 2 and Table 9, respectively;

- surface profile of PE/PP coating (e.g. prior to concrete weight coating or special laying methods);
- surface pretreatment;
- special requirements relative to supply of coating materials (e.g. FBE or liquid, manufacturer-specific products and certification);
- methods, frequency and acceptance criteria for inspection and testing differing from this part of ISO 21809;
- procedure qualification trial (PQT);
- protection against adverse ambient conditions during storage.

7 Coating classification

7.1 General

Coating class shall be selected based on the design temperature range and expected field duty.

Coating thickness class shall be selected based on transport, handling, laying conditions and the expected operating and environmental conditions.

7.2 Coating classes

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The coating shall be capable of withstanding the temperature range required, as shown in Table 1. The coating class shall be specified in the purchase order.

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Table 1 — Coating classes and design temperature ranges

Coating class	A	B	C ^a
Top layer material	LDPE	MDPE/HDPE	PP
Design temperature ranges (°C)	-20 to +60	-40 to +80	-20 to +110
^a Installation and transportation at temperatures below 0 °C can cause mechanical damage.			

Use of coating classes outside these guidelines shall be approved by the purchaser or end user.

7.3 Coating thickness classes

Coating thickness class shall be selected by the purchaser or end user based on installation and service conditions and pipe dimensions. The coating thickness class, as shown in Table 2 as a function of coating class and pipe weight, shall be specified in the purchase order.

Table 2 — Minimum total coating thickness

P_m kg/m	Total coating thickness ^a mm								
	Class A1 ^b	Class A2 ^c	Class A3 ^d	Class B1 ^b	Class B2 ^c	Class B3 ^d	Class C1 ^b	Class C2 ^c	Class C3 ^d
$P_m \leq 15$	1,8	2,1	2,6	1,3	1,8	2,3	1,3	1,7	2,1
$15 < P_m \leq 50$	2,0	2,4	3,0	1,5	2,1	2,7	1,5	1,9	2,4
$50 < P_m \leq 130$	2,4	2,8	3,5	1,8	2,5	3,1	1,8	2,3	2,8
$130 < P_m \leq 300$	2,6	3,2	3,9	2,2	2,8	3,5	2,2	2,5	3,2
$300 < P_m$	3,2	3,8	4,7	2,5	3,3	4,2	2,5	3,0	3,8

^a The required total coating thickness may be reduced by a maximum of 10 % on the weld seam for SAW-welded pipes.

^b Class 1 is for light duty (onshore sandy soil).

^c Class 2 is for moderate duty (clay soils, absence of backfill).

^d Class 3 is for heavy duty (rocky soil or offshore).

Use of thickness classes outside of these guidelines shall be approved by the purchaser or end user.

8 Coating materials

8.1 Composition of the coating system

The coating system shall consist of three layers: [ISO 21809-1:2011](https://standards.iteh.ai/standards/sist/7246d58-8e36-495c-80f2-0f8a1ed138a9/iso-21809-1-2011)

- 1st layer: epoxy;
- 2nd layer: adhesive;
- 3rd layer: PE/PP top layer.

8.2 Qualification of the coating materials

8.2.1 General requirements

The manufacturer shall qualify each type of coating material in compliance with the requirements of this part of ISO 21809. The qualification shall be repeated in case of changes in the material composition, changes in the production process which influence the material processing behaviour and change in production facility.

The manufacturer shall carry out and report the material qualification in accordance with the requirements of Clause 8 and Tables 3, 4 and 5. The test report shall contain the results of the qualification tests and the data required in Table 6.

The applicator receiving the manufacturer's test report shall verify that it meets the requirement of this part of ISO 21809.

8.2.2 Epoxy material

The applicator shall use epoxy material that is in accordance with Table 3.